

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

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BELGIQUENOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
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Applicant's or agent's file reference
S2648-PCT

IMPORTANT NOTIFICATION

International application No.
PCT/BE 03/00178International filing date (day/month/year)
21.10.2003Priority date (day/month/year)
21.10.2002Applicant
STMICROELECTRONICS N.V. et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

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PATENT COOPERATION TREATY
PCT
INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference S2648-PCT	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)
International application No. PCT/BE 03/00178	International filing date (<i>day/month/year</i>) 21.10.2003	Priority date (<i>day/month/year</i>) 21.10.2002
International Patent Classification (IPC) or both national classification and IPC H04L27/26		
Applicant STMICROELECTRONICS N.V. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 11 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:
- I ☒ Basis of the opinion
 - II ☐ Priority
 - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - IV ☒ Lack of unity of invention
 - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - VI ☐ Certain documents cited
 - VII ☐ Certain defects in the international application
 - VIII ☐ Certain observations on the international application

Date of submission of the demand 29.04.2004	Date of completion of this report 09.03.2005
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**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/BE 03/00178

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-27 as originally filed

Claims, Numbers

1-22 received on 14.02.2005 with letter of 14.02.2005

Drawings, Sheets

1/24-24/24 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees, the applicant has:

- ☐ restricted the claims.
☒ paid additional fees.
☐ paid additional fees under protest.
☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
☒ not complied with for the following reasons:

see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-22
	No: Claims	
Inventive step (IS)	Yes: Claims	18
	No: Claims	1-17, 19-22
Industrial applicability (IA)	Yes: Claims	1-22
	No: Claims	

2. Citations and explanations

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/BE 03/00178

see separate sheet

Re. IV

The following separate inventions or groups of inventions are not so linked as to form a single general inventive concept:

1. Claims 1-5, 8-13, 19-22

The subject-matter of these claims is a receiver/method for performing frequency offset estimation using an autocorrelation of the receive signal, and time synchronization using a cross-correlation of the frequency-offset compensated signal.

2. Claims 6, 7, 14, 15:

The subject-matter of these claims is a receiver, wherein threshold values are used to detect peaks and in particular also troughs in the characteristic curve.

3. Claims 16-18:

The subject-matter of these claims is a receiver, in which a time reference is obtained from an autocorrelation and cross-correlation signal, and it is decided which time reference is outputted.

The features of claim 1 are rendered obvious by Document WO-A1-0077961 cited in the International Search Report (see section V).

Compared to the subject-matter disclosed in WO-A-0077961,

- the potential special features of the **1st** group of claims are represented by the features of claims 4 and 12, ie. a characteristic curve is detected in the phase of the autocorrelation signal, which is directed to the problem of providing an alternative detection scheme in contrast to (solely) amplitude detection.
- the potential special features of the **2nd** group are represented by the features of claims 6 and 14, ie. to detect troughs in the characteristic curve, which is directed to the problem of improving the detection of the characteristic curve in contrast to solely peak detection.
- the potential special features of the **3rd** group are represented by the features of claim 16, ie. the time reference obtained by autocorrelation is outputted if the reference obtained by cross-correlation is not present, which is directed to the

problem of achieving a more flexible time synchronization scheme.

A-posteriori, there exists no single general inventive concept forming a link between any of the special technical features of groups 1-3.

Consequently, the inventions represented by the above groups do not possess any corresponding special technical features as required by Rule 13.2 PCT and are thus not so linked as to form a single general inventive concept, Rule 13.1 PCT.

Re. V

Reference is made to the following document(s):

- D1: WO 00/77961 A (KIM KWANG CHUL ;SAMSUNG ELECTRONICS CO LTD (KR))
21 December 2000 (2000-12-21)
- D2: EP-A-1 071 251 (NIPPON TELEGRAPH & TELEPHONE) 24 January 2001 (2001-01-24)
- D3: ALMENAR V ET AL: "SYNCHRONIZATION TECHNIQUES FOR HIPERLAN/2"
VTC FALL 2001. IEEE 54TH. VEHICULAR TECHNOLOGY CONFERENCE.
PROCEEDINGS. ATLANTIC CITY, NEW JERSEY, OCT. 7 - 11, 2001, IEEE
VEHICULAR TECHNOLOGY CONFERENCE, NEW YORK, NY: IEEE, US, vol. 2
OF 4. CONF. 54, 7 October 2001 (2001-10-07), pages 762-766, XP001124248
ISBN: 0-7803-7005-8
- D4: PAEZ-BORRALLLO J M ET AL: "A new time-frequency synchronization scheme for
OFDM-TDMA systems" VEHICULAR TECHNOLOGY CONFERENCE, 1999 IEEE
49TH HOUSTON, TX, USA 16-20 MAY 1999, PISCATAWAY, NJ, USA,IEEE, US,
16 May 1999 (1999-05-16), pages 2408-2412, XP010342259 ISBN: 0-7803-5565-
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OBJECTIONS WITH RESPECT TO ARTICLE 6 PCT

1. The independent claims 1 and 22 do not meet the requirements of Article 6 PCT for the following reason:

Both claims fail to define that the "initial information" is used for obtaining the "estimate of a carrier frequency offset". As a result, the subject-matter of both claims is not clear

and not supported by the description.

Invention no. 1: Claims 1-5, 8-13, 19-22

2. The subject-matter of independent claim 22 does not involve an inventive step over the disclosure of document D1. D1 discloses to obtain an estimate of the frequency offset by autocorrelation (see Fig. 2, the output of the multiplier 216), moving average calculation (element 218) and an additional averaging of the frequency offsets within the flat section in Fig. 4B (see page 4, lines 11-15). Fig. 4B shows the signal at the output of the normaliser 219.

In general, it is not possible to distinguish a single training sequence (e.g. 1101) from the concatenation of two training sequences (e.g. 11 and 01). As a result, the whole synchronization symbol in D1, Fig. 4A can be construed to consist of two training sequences, (ie. the first being the first two SYNC_A symbols, and the second being the last two SYNC_A symbols).

Hence, D1 discloses according to the features of claim 22 (the corresponding features in D1 are given in brackets):

A method for processing a received signal comprising a modulated carrier having a frame with first and second training sequences [Fig. 3, step 302, Fig. 4, the first two and the last two SYNC_A symbols of 32 samples each, page 6, lines 7-9], comprising:

- obtaining initial information [a sample at the output of element 216] relating a carrier frequency offset from an autocorrelation signal obtained by autocorrelation of the first training sequence [one of the samples at the output of element 216 when the second SYNC_A symbol is received and the first SYNC_A symbol is output from the delay unit 221]
- obtaining an estimate of a carrier frequency offset [page 4, lines 11-15: the average frequency offset value output of the averaging unit] from an autocorrelation signal obtained by autocorrelation of another part of the whole training sequence of the received signal [page 4, lines 11-15: for averaging, at least two samples within the flat section are used, each sample corresponds to the autocorrelation of one part of the whole training sequence. As a result, the output of the averaging unit is based on the autocorrelation of two different parts of the

whole training sequence];

- compensating the received signal with the obtained estimate of the frequency offset to form a compensated received signal [Fig. 3, step 316], and
- obtaining a timing reference for the received signal by cross-correlation of the compensated received signal with a known training sequence [Fig. 3, steps 318-324].

Consequently, the subject-matter of claim 22 differs from the method of D1 in that D1 does not teach which samples within the flat section of Fig. 4B are used for averaging to obtain the average frequency offset value, and consequently D1 does not teach to use a sample within the second half of flat section.

However, since a skilled person would, in order to obtain a reliable averaging result, avoid the selection of two neighbouring samples, since errors in neighbouring samples are likely to be correlated. A skilled person would choose for averaging two (or more samples, see page 4, lines 11-15: "two or more times") located in different parts of the flat section (e.g one sample from the first and one from the second half of the flat section). A sample in the second half of the flat section of Fig. 4B depends on the autocorrelation of the second part of the training sequence (ie. the last two SYNC_A symbols).

The skilled person, therefore, being aware of the disclosure of D1 would apply common general knowledge of the art in order to obtain a reliable averaging result and arrives at a system according to claim 22 without involving an inventive step.

As a consequence, claim 22 does not meet the requirements of Article 33(3) PCT for lack of inventive step of its subject-matter.

3. The same arguments as above apply to the subject-matter of claim 1 which corresponds to that of claim 22 in terms of apparatus features. Therefore the subject-matter of claim 1 does not involve an inventive step (Article 33(3) PCT).
4. Dependent claims 2-5, 8, 9, 11-13, 19-21 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step (Article 33(3) PCT), the reasons being as follows:
 - i. Claim 2: cf. D1, Fig. 3, steps 310 and 322;

- ii. Claims 3, 8: cf. D2, column 14, line 50;
 - iii. Claim 4: cf. D3, section III;
 - iv. Claim 5: cf D1, page 4, lines 5-10
 - v. Claim 9, 10: cf. D2, column 14, line 50 and column 15, line 18 "opposite phase rotation", remark: it is implicit that the sign of the phase and the sign of the frequency offset are related and the frequency offset correction has to be done in the right direction.
 - vi. Claims 11, 12: cf. D2, paragraph 33 and 44 or D3, page 764, left-hand column, "A search" and "AB search".
 - vii. Claim 13, 19: cf. D1, page 8, lines 2-17
 - viii. Claim 20: cf. D5, column 10, lines 14-39 and Fig. 6
 - ix. Claim 21: cf. D1
5. The documents in the International Search Report do not seem to suggest to determine the carrier frequency offset (CFO) from a long training sequence after the determination of the sign of the CFO from a short training sequence (as described on page 14, lines 3-5).

Invention no. 2: Claims 6, 7, 14, 15

6. The subject-matter of apparatus claim 6 does not involve an inventive step over the disclosure of document D1.

The additional features of claim 6 compared to the receiver of claim 1 are the use of thresholds values to detect peaks and troughs, which corresponds to the problem of *improving the detection algorithm for detecting the characteristic curve*.

However, the use of thresholds to detect peaks and troughs in the amplitude of the autocorrelation signal in order to increase the reliability (ie. to reduce false alarm of the detection) is disclosed in document D3, page 764, left-hand column, "AB search" and right-hand column, last paragraph.

The indications provided by the prior art would prompt the skilled person, when looking

for a solution to the above-mentioned problem, to include the teaching of D3 into the prior art, thus arriving at an apparatus corresponding to the subject-matter of claim 6 without involving an inventive step.

As a consequence, claim 6 does not meet the requirements of Article 33(3) PCT for lack of inventive step of its subject-matter.

7. The same objection equally applies to the wording of corresponding claim 14. As a consequence, claim 14 does not meet the requirements of Article 33(3) PCT for lack of inventive step of its subject-matter.
8. Dependent claims 7 and 15 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step (Article 33(3) PCT), the reason being as follows:

The use of adaptive thresholds is disclosed in D3, page 766, left-hand column, paragraph 4.

Invention no. 3: Claims 16-18

9. The subject-matter of apparatus claim 16 does not involve an inventive step over the disclosure of document D1.

The additional feature of claim 16 compared to the receiver of claim 1 is the output of a autocorrelation timing reference in case the cross-correlation timing reference is not present, which relates to the problem of designing a more flexible time synchronization algorithm.

However, document D4 discloses (see page 2409, right-hand column, last paragraph) that time synchronization can be done in two steps: the first step consists of performing an autocorrelation on the received signal to obtain coarse time synchronization for potential fine time synchronization, and the second step consists of performing a cross-correlation to obtain fine time synchronization. It is implicit that the first step is carried out because the timing reference obtained from the cross-correlation is not present. Moreover, the expression "potential" indicates that the second step is optional.

The indications provided by the prior art would prompt the skilled person, when looking for a solution to the above-mentioned problem, to include the teaching of D4 into the

prior art, thus arriving at a apparatus corresponding to the subject-matter of claim 16 without involving an inventive step.

As a consequence, claim 16 does not meet the requirements of Article 33(3) PCT for lack of inventive step of its subject-matter.

10. With respect to claim 17, document D4 discloses to output the timing reference determined by cross-correlation if it is present (see page 2409, right-hand column, last paragraph). Consequently, claim 17 does not meet the requirements of Article 33(3) PCT for lack of inventive step of its subject-matter.
11. The documents in the International Search Report do not seem to suggest to output a reset signal if the two timing references differ by more than a threshold value and to otherwise output the timing reference obtained from the cross-correlation (claim 18)

Certain defects in the international application

When entering the national or regional phase, the following points should also be taken into account:

1. The independent claims have not been properly cast in the two-part form, with those features known in combination from the prior art (see document D1) being placed in a preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in a characterising part (Rule 6.3(b)(ii) PCT). Thus, the requirements of Rule 6.3(b) PCT are not met.
2. The requirements of Rule 5.1(a)(ii) PCT are not met, since the closest prior-art document D1 is not identified in the description and the relevant background art disclosed therein is not briefly discussed.
3. Furthermore, the statement indicating the technical problem to be solved by the invention does not take the disclosure of document D1 into account. Hence, the requirements of Rule 5.1(a)(iii) PCT are not met.
4. Reference signs placed in parentheses have not been inserted into all the claims to increase their intelligibility. Hence, the requirements of Rule 6.2(b) PCT are not met.

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Claims

1. A receiver for receiving a signal, comprising a modulated carrier, with a frame
5 having first and second training sequences, comprising:
 - a frequency offset estimation unit for receiving the signal and obtaining initial
information relating a carrier frequency offset from an autocorrelation signal
obtained by autocorrelation of the first training sequence and for obtaining an
estimate of a carrier frequency offset from an autocorrelation signal obtained by
autocorrelation of the second training sequence of the received signal;
 - 10 a frequency offset compensation unit for compensating the received signal with the
frequency offset obtained from the frequency offset estimation unit to form a
compensated received signal, and
 - a time reference determining unit for obtaining a timing reference for the received
signal by cross-correlation of the compensated received signal with a known
15 training sequence.
2. The receiver according to claim 1, wherein the time reference determining unit is
adapted to obtain a first timing reference for the received signal by autocorrelation
of the received signal and a second timing reference for the received signal by the
cross-correlation of the compensated received signal with the known training
20 sequence.
3. The receiver according to claim 1 or 2, wherein the frequency offset estimation
unit comprises means for determining a phase shift in the autocorrelation signal of
the received signal.
4. The receiver according to any previous claim, wherein receiver comprises means to
25 detect a characteristic curve indicative of a known training sequence in the phase of
the autocorrelation signal.
5. The receiver according to any previous claim, wherein the receiver comprises
means to detect a characteristic curve indicative of a known training sequence in
the amplitude of the autocorrelation signal.
- 30 6. The receiver according to claim 4 or 5, wherein the characteristic curve includes
peaks and/or troughs and threshold values are used to detect peaks and troughs.
7. The receiver according to claim 6, wherein the threshold values are set
dynamically.
8. The receiver according to any of claims 3 to 7, wherein the frequency offset

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estimation unit comprises means for determining the carrier frequency offset from the phase shift.

9. The receiver according to any previous claim, wherein the receiver comprises means to determine a sign of the CFO from the phase of the autocorrelation signal from a known sequence.
10. The receiver according to claim 9, wherein the receiver has means for determining a phase shift in the autocorrelation signal from a further known sequence of the received signal.
11. The receiver according to any previous claim, wherein the time reference determining unit comprises means to determine a characteristic curve indicative of a known training sequence in the amplitude of the autocorrelation signal.
12. The receiver according to any previous claim, wherein the time reference determining unit comprises means to determine a characteristic curve indicative of a known training sequence in the phase of the autocorrelation signal.
13. The receiver according to any previous claim, wherein the time reference determining unit comprises means to determine a characteristic curve indicative of a known training sequence in the amplitude of the cross-correlation of the compensated received sequence with the known training sequence.
14. The receiver according to claim 13, wherein the characteristic curve includes peaks and/or troughs and threshold values are used to detect peaks and troughs.
15. The receiver according to claim 14, wherein the threshold values are set dynamically.
16. The receiver according to any previous claim, wherein the receiver is adapted to output the timing reference obtained from the received signal by autocorrelation of the received signal if the timing reference obtained by cross-correlation of the compensated received signal with the known training sequence is not present.
17. The receiver according to claim 16, wherein the receiver is adapted to otherwise output the timing reference determined by cross-correlation of the received signal.
18. The receiver according to claim 16, wherein the receiver is adapted to compare the timing reference for the received signal obtained by cross-correlation of the compensated received signal with the known training sequence when present and the timing reference determined by autocorrelation of the received signal, and to output a reset signal if the two timing references differ by more than a threshold

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value and otherwise to output the timing reference for the received signal obtained by cross-correlation of the compensated received signal with the known training sequence.

19. The receiver according to any previous claim wherein the timing reference
5 determining unit is adapted to determine a symbol timing from a correlation peak in the cross-correlation of the received signal with the training sequence.
20. The receiver according to any previous claim, wherein the received signals also contain a cyclic prefix, further comprising: means for obtaining an accurate value
10 for the carrier frequency offset by autocorrelation of the cyclic prefix with the received signal.
21. An OFDM telecommunications system including a receiver according to any of the claims 1 to 20.
22. A method for processing a received signal comprising a modulated carrier having a
15 frame with first and second training sequences, comprising:
obtaining initial information relating to a carrier frequency offset from an autocorrelation signal obtained by autocorrelation of the first training sequence;
obtaining an estimate of a carrier frequency offset from an autocorrelation signal
obtained by autocorrelation of the second training sequence of the received signal;
compensating the received signal with the obtained estimate of the frequency offset
20 to form a compensated received signal, and
obtaining a timing reference for the received signal by cross-correlation of the compensated received signal with a known training sequence.